
 XV. *Remarks on the Nature and Propagation of marine Plants.*

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HAVING, in a former inquiry into the mode of propagation peculiar to marine plants, attempted to point out some material errors, which accompanied the theories of Gmelin and Gærtner, by proving, that the membranaceous *Fuci*, which the former considered as merely prolific, derived their origin from actual seeds; and that the numerous tribe of *Confervæ*, which Gærtner, upon a very slight and superficial examination, has dogmatically declared to be destitute of feminal increase, were beyond a doubt dependent upon the same general law of Nature, for their propagation, as the *Fucus*: I shall now lay before this Society some further observations upon the subject, arising principally from an examination of the recent theories that have very lately made their appearance in the world. It may not however be foreign to the purpose, to investigate the definition of the generic character prefixed by Linnæus to the *Fucus*, and which does not appear to be clearly stated.

In the *Genera Plantarum* he defines the supposed male flower as follows: "Vesiculæ glabræ, cavæ, pilis intus aspersæ;" rendered by the Lichfield Society, "Vesicles smooth, hollow, sprinkled with hairs within;" and in the *Nereis Britan.* "Bladders smooth; hollow, interspersed within with soft hairs." Linnæus, however, cautiously introduces this definition upon the authority of Reaumur;

he disclaims all pretensions to the discovery upon which it is founded, and moreover asserts, in the *Philosophia Botanica*, that the florescence of the *Fucus* had been first brought to light by that author. Now Reaumur in no instance admits that the male flowers are contained in the air-bladders. On the contrary, he positively maintains that the pencilled clusters of fine hairs, spread on the surface, are the male flowers exclusively. Whatever ambiguity, therefore, may be attached to the word "vesiculæ" as applied by Linnæus, or however he may have varied his mode of expression at different times, still we are to recur to the account of the discovery, as stated by Reaumur, for the real import and meaning which ought to have been conveyed in the definitions of Linnæus; since on that alone his doctrine of the male flower appears to rest. The description cited above from the *Genera Plantarum* seems evidently to relate to the air-bladders in the *Fucus vesiculosus*, and has induced some authors to consider the fructification as confined to those parts*;—while others again, pursuing the same opinion, and who at the same time adopt the doctrine of Reaumur and Donati, that the pencilled clusters of hairs, scattered over the surface of the frond, are the male flowers, will find themselves reduced to the necessity of admit-

* In the last edition of the *Botanical Arrangements* it is observed, under *Fucus vesiculosus*, that "the bladders in the substance of the leaf contain the fructification." Dr. Withering, agreeably to the method which he has constantly pursued throughout that valuable work, very properly produces the authority of Linnæus in support of the above opinion. In the same work, the *Fucus serratus* is also noticed as having "two kinds of fructifications sufficiently obvious;" *i. e.* the seed-vessels in the summits, and the clusters of fine hairs externally situated. But it must not be passed over, that the same appearances are equally obvious on the *Fucus vesiculosus* and all its varieties. Admitting therefore that the male flowers are contained in the air-bladders, the *Fucus vesiculosus* must of course have three distinct parts of fructification; one exposed, another concealed, and the third in the summits (universally admitted) producing the seeds.

ting two different males, on the same plant, operating in a manner not only distinct from, but directly opposite to, each other: for one of them (as we have just seen) is described as internally situated and concealed in the air-bladders, while the other is external and exposed to view in those small open vessels upon the surface of the plant*. But such an œconomy does not appear to have proof or analogy

* My friend Mr. Stackhouse had adopted the same opinion in his very ingenious investigation of these plants, and mentioned "the monœcious character as clearly discernible in some" of the *Fuci*; as also the twofold state of the male flowers, one of which is represented as externally situated, and exposed to view in the urceolate vessels; the other, concealed in the air-bladders—"in interiore vesicularum grandiorum." In a subsequent fasciculus he informs us, with that true spirit of candour which directs his researches and entitles them to the most respectful attention, that the doctrine of a monœcious character must be totally abandoned, since upon a more critical and attentive examination he finds "the previous fructification is effected internally." This last point being admitted, there hardly remains a shadow of difference between our respective opinions, as far as relates to the propagation of this curious tribe of plants. I must observe, however, that as I could not in the first instance attribute to those capillary vessels the important function which belongs to a state of florescence, so neither can I reconcile myself to a contrary extreme, "that those filaments might be nothing more than an exuding mucus"—admitted in the second fasciculus of *Ner. Brit.* p. 13. This opinion is taken up principally upon the disappearance of those fine hairs when immersed in water; as if they at once became resolved into a mucous fluid. But the fact is, they still remain in the same unaltered state, and may be discovered in the aquatic microscope in a strong light during their immersion. Their extreme tenuity and minuteness may cause them to collapse, and adhere to the surface of the plant; and their tone of colour, which may assimilate itself to that of water, will no doubt render them difficult to be seen. These pencilled clusters are represented in the first plate and fasciculus of the *Ner. Brit.* in their urceolate vessels. If they were destined to carry off the mucus, they would not be excluded from the internal mass by those callous vessels in which they are confined. If they were part of the fluid, they would be of very different lengths. Besides, these filaments exist when the plants are in their first and most tender state (as I have observed upon a former occasion), and before they produce the least appearance of mucus. This fluid is not constantly produced, and principally abounds in a state of maturity. In summer time it may sometimes be seen

analogy to ſupport it, throughout the whole vegetable creation. The locality of two ſuch bodies demonſtrates their reſpective functions to be diametrically oppoſite; for, while the favourite idea of florefcence may ſuggeſt the poſſibility of external communication, between the minute filaments on the ſurface and the fruſtified ſummits which contain the feeds, the ſituation of the ſecond flower in a bladder, ſo impervious as to retain its internal air, neceſſarily excludes the poſſibility of a groſſer body eſcaping externally through ſuch a ſubſtance. Should it be aſſerted, that the fecundating principle therein contained may be of ſo pervading a nature as to find an internal courſe through the ſolid coriaceous texture of the frond itſelf; although, for reaſons which I ſhall hereafter aſſign, I cannot admit that it exiſts in thoſe bladders, yet I concur in the general principle. It is what I have chiefly endeavoured to point out in my former tract upon this ſubject. If then, to uſe the expreſſion of the ingenious author of the *Nereis Britannica*, “the impregnation may be effected by a ſubtile vapour,” in other words, by ſome unknown operation, the fact ſeems highly probable. This is “that ſelf-inherent principle” which I before aſſerted to exiſt, and upon the apparent œconomy and wiſdom of the Divine Author, “who has admirably tempered the conſtituent principles of natural bodies in ſuch due proportions as might beſt fit them for the ſtate and purpoſes they were intended for*.” But then we ought not, upon mere hypotheſis, to wreſt ſuch hidden faculties (for unknown ſurely they are) from their inſcrutable courſe, and arbitrarily aſſign their effects to the ſuppoſed

before it is diſengaged from the frond; and then it forms a very curious depôt immediately under the ſurface, appearing like diſtinct globules extremely minute. In this ſtate I have ſeen it in very thin tranſverſe ſections of the *Fucus ſaccharinus* under the microſcope. At firſt ſight I ſlattered myſelf I had diſcovered the feeds of that *Fucus*.

* Hales.

mechanical operation of parts, which are neither calculated to promote, or capable of communicating, those reciprocal functions which result from a state of floescence.

It has been justly observed by one of the greatest philosophers of the present age*, "that Nature though varied is generally uniform in her operations." The more we contemplate the extensive volume which she presents to our view, the more this observation will become confirmed: but while it tends to vindicate the existence of a principle equivalent to, as I have before maintained, though differently modified from, that which directs the sexual system, it cannot reconcile itself to the assumption of two distinct males acting by different processes in the same plant; any more than it can admit either of those bodies separately to constitute a state of floescence, when, from their permanent and unchangeable nature through all the successive periods of the plant's existence, as well as from their relative situations, they militate against every law of analogy, as far as respects the Linnean system.

Linnæus, when he maintains the universal influence of the laws of floescence over the vegetable world, closely defines the precise character of the flower itself, asserting, that its very essence exists in the stigma and antheræ, which, connected with the pollen containing the fertilizing vapour, can alone constitute a state of floescence; and that, without these essential parts, even the blossom with its exterior appendages could not in any respect be considered as a flower.

The uniformity and mechanical exactness which directs the sources of vegetable impregnation, throughout the immense series of terrestrial plants, could not fail to attract the admiration of the recent votaries to the sexual system. Strengthened in their opinions

* Sir William Hamilton.

by the general conformity of the laws of Nature, and exulting in the confutation with which modern discoveries had overwhelmed the former prevailing theories, it is not matter of surprize that they should have established the laws of florescence upon so strict a dogma. Science, too long insulted by the preposterous tenets of equivocal generation, had already turned away in disgust from the ancient writers, who favoured that ill-founded doctrine. The principles of vegetable life now became the object of philosophical discussion; and the important discovery of Harvey, which had long since brought to light the circulation of the blood, seems, by an easy transition, to have directed the researches of Hales towards a similar principle in vegetable bodies; when, at length, the propulsion of the sap became beautifully exemplified by his unerring staticks. Every day brought forth new discoveries; and those plants which had apparently furnished the strongest arguments to the opponents of the system, were now compelled to disclose their mysterious œconomy, and, by exhibiting the hidden sources of their impregnating powers, seemed at once to establish the universal extent of the newly established doctrine. When Linnæus first announced the discovery of seeds in the Moss, was it to be expected that he should withhold his credit from the florescence of the *Fucus*, when brought to light by one of the most respectable philosophers of his day? The florescence however of the *Fucus*, as it is stated in the *Nereis Britannica* to exist, derives no support from that of the submersed plants. On the contrary, the latter tend to establish a strong argument against the abovementioned theory. Almost all those aquatic plants that are fertilized by actual pollen, a substance known to be immiscible with water, emerge at the time of their impregnation. Let us examine, as next in succession, the very few which do not emerge. And first the *Isoetes* seems to present itself, whose flower

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is so carefully enveloped with an impenetrable barrier, formed by the concave position of the leaves, that the pollen is enabled to convey its fertilizing vapour in an element, which by contact would obstruct the progress of fecundation. The genus *Chara* seems to indicate an approach towards that terminating point, where the mechanical florescence ceases at length to act. Some respectable authors, and Haller among the number, do not admit that the supposed antheræ can be invested with the faculty of impregnation, because they are permanently included in an impervious part of the plant. Hedwig, who has defined the florescence of this genus with great precision, acknowledges himself to be totally at a loss to account for that operation, because the spherical vessel, in which the antheræ* are included, has no external communication with the approximating germ. It is very probable, however, that the vessel alluded to may, from its contiguity to the lower part of the germ, convey thither, at the point of contact, the impregnation by an internal process. A very slight comparison will at once discover the total want of similitude in structure, situation, and œconomy, between the vessels of the *Chara*, in which the fecundation appears to be carried on internally, and those air-bladders in some of the *Fuci*, supposed to be the residence of the male flower.

Enough has already been said upon the Linnean state of florescence. We have a clear and restricted definition of its constituent parts, while its laws are found to accord with surprising uniformity through all the various classes, which were formed by the great founder of the system. Yet there is a point where its accustomed mechanism ceases to act; where the nature and agency of its impregnating powers undergo a material change. And here surely we may pause, to contemplate the versatile power by which Nature is

* *Theor. Hedw.* p. 129.

enabled.

enabled to vary, without disuniting, the general principles of her established laws. "She disdains," as Mr. Lightfoot has finely observed, "to be limited by the systematic rules of human invention. She never makes any sudden starts from one class or genus to another, but is regularly progressive in all her works, uniting the various links in the chain of beings by insensible connections."

We have lately seen this mysterious subject discussed by no ordinary investigator of Nature's laws*. The principle upon which this discerning naturalist proceeds, appears to be well founded; and if he fails in any respect, it is by overstraining his theory to make it quadrate with the Linnean doctrine of floescence. From this circumstance principally, he has, in my opinion, exposed his argument to some objections which may not easily be removed. He commences his essay with a concise and perspicuous survey of the existing theories laid down by Reaumur, Gmelin, and Gærtner. And as the two last of those authors maintain that a very numerous branch of the *Algas* do not in any instance derive their origin from seeds, but solely from proliferous gems, or buds, he opposes the doctrine with much ingenuity; not grounding his opinion merely upon the laws of analogy, but upon a scientific and an anatomical inquiry into the natural structure and constituent parts, as well as situation, of these corpuscles.

Having, as far as the nature of the subject would admit, established these points so consonant with sound philosophy, he proceeds to account for that peculiar process to which the seeds themselves owe their origin; and this he considers as an actual state of floescence. "If pollen," continues this author, "under the shape of farina, be unfit for fecundation in the water; if Nature has taken

* Mr. Correa de Serra on the Fruetification of the submerged *Alge*, in The Philosophical Transactions for the year 1796, p. 494.

a particular

a particular care to guard this operation from the presence of that element; if pollen can exist in an active state under a mucous appearance; and if the antheræ of perfectly submersed flowers are nothing else than closed vessels filled with mucous pollen; what doubt can we entertain, that the mucilaginous vesicles of the submersed *Algæ* (which contain also their seeds) are antheræ?"

I shall now briefly consider this theory of florescence, as taken up upon the principles established by Linnæus, and explained in the technical language of that author. It may perhaps scarcely be worth while to observe, that Mr. Correa de Serra, at the beginning of the above passage, appears to make a distinction between the terms *pollen* and *farina*, which in fact are merely synonymous. Pollen, as explained by Linnæus in the *Philosophia Botanica*, seems to have a reference to the exterior form and appearance of the body itself, more than to the fecundating vapour or power contained within it, to which it acts principally as a vehicle*. This part of the flower being almost universally found under a farinaceous form, is distinguished by the appropriate term *pollen*, which implies a fine meal. Waving therefore any objection that might be raised against the expression "mucous pollen," I cannot pass over a subsequent remark, in which the faculty of impregnation is attributed to the part containing the seeds; and the province of the antheræ, so distinctly preserved in the sexual system, is nearly blended with that of the seed-vessel. The passage alluded to is the following: "What doubt can we entertain, that the mucilaginous vesicles of the submersed *Algæ* (which contain also their seeds) are antheræ?" In short, if the reproduction of these plants is to be elucidated by the Linnean theory of florescence, and its concomitant terms, especial care should be

* Generationem vegetabilium fieri mediante pollinis antherarum illapsu supra stigmata, quo rumpitur pollen, efflatque *auram feminalem*, quæ absorbetur ab humore stigmatis.
Ph. Bot. sect. 145.

taken to preserve a strict connection, and uniform correspondence, between the parts described, and the definitions by which the theory is supported. Gærtner, in his remarks upon some of the *Fuci*, finding that their fecundation was effected by an internal process, maintains likewise, that the part containing the seeds is also endued with the faculty of impregnation. But this author gives an unphilosophical and a fanciful cast to his hypothesis, in adopting an unisexual distinction, when he supposes that the female organ impregnates itself, or rather, the ovula which it contains—"quod ipse uterus sua fecundet ovula, et quod ille ipse officia genitalium utriusque sexûs, præstet solus."—Upon examining the mucilaginous vesicles (or, strictly speaking, the distended summits) in which the seeds are placed, and considered also by Mr. Correa de Serra as the antheræ, it will appear that the seeds are very seldom fixed in a loose and naked state, but contained in minute hard coriaceous tubercles, on all sides impervious*, and most firmly attached to the interior surface of the summit, in the vesicular *Fuci*; and that in these tenacious tubercles the seeds may frequently be discovered long before the solid cellular mass becomes changed into a mucilaginous substance. Again, in several species, the central substance, in which the seeds or pericarps are placed, always remains in an invariably solid state, and is never converted into mucilage. This is decidedly the case in the *Fucus serratus* †, and I never found it otherwise in the *Fucus nodosus* and some others; and yet the seeds of both those plants are produced in the same manner as in the *Fucus vesiculosus*. From these facts there is great reason to conclude, that the mucus, which is found at certain seasons in several of the *Fuci*, is not essentially necessary to their impregnation. And as it seems to abound most in

* See the horizontal section of one of the summits of *Fucus vesiculosus*, in which the tubercles or pericarps are represented. *Vell. Marine Plants*, plate 1.

† See an horizontal section of this *Fucus* magnified, *Marine Plants*, plate 1.

the mature plants, I am induced to suppose that it may be a kind of suppuration brought on by age, and possibly may be instrumental in facilitating the escape, or dispersion, of the seeds.

A plausible remark in favour of the hypothesis is urged by the ingenious author in the following words: "The pollen of any flower, when put into water, in a very short time begins to move; and its particles agitate themselves in every direction, perfectly resembling the most lively animalcula. Their activity in this state lasts some time; but if the least quantity of salt be put into the liquor, death quickly ensues, from which they never more recover. This inclosed mucilaginous fructification was therefore the only one which could ensure existence to vegetables living chiefly in sea-water, with which their mucus is found to be immiscible."

It is very far from my intention to misrepresent the meaning of the passage. It strikes me, as alluding to a provision which Nature has made to protect the impregnating body from the deleterious effect of saline particles (which would at once destroy the active principle of pollen), by fixing it in a menstruum which is immiscible with sea-water. The supposition is ingenious. Yet is Mr. Correa de Serra aware, that this very mucilage is not free from the infection of salt;—that saline particles may frequently be found upon the surfaces of dried specimens;—that in dissections under the microscope similar appearances may be discovered, which suddenly shoot into minute crystallizations;—and that it is owing to this saline quality which seems intimately combined with the very texture and constituent parts of the *Fuci*, that they possess the property of an hygrometer for years after they are dried*?"—From these circumstances it

* I am induced, from an observation of Mr. Lightfoot, to attribute this circumstance to the natural quality of the frond, rather than to the effect of the sea-water in which it grew. That author remarks, that if the *Fucus saccharinus* be soaked in fresh water, then

it appears to be highly probable, that the pollen of marine plants, if such a body in reality may exist in the mucilage, must be totally different in its quality from the pollen which carries on so important a function in the sexual system: it must also be totally different in its substance, because it is not to be discovered by the greatest magnifying powers.

But, giving the utmost scope to the hypothesis, and admitting that this mucous pollen is attendant upon all the marine plants, either internally or externally; still it must contain some subtle vapour, capable of passing through the coriaceous texture either of the tubercular pericarps or of the frond. And after all, what does this amount to? Nothing more than that some undefined vivifying principle, resident in the internal substance of the plant, brings on a state of impregnation, and answers every purpose which the more obvious mechanical laws of floescence produce externally in an atmosphere, where no impediments exist to render their process abortive.

After what has been already advanced, it may appear almost superfluous to produce any further arguments against the floescence supposed to be concealed in the inflated parts of the vesicular *Fuci*. I shall therefore only briefly add, that the *Fucus ferratus* is entirely destitute of the air-bladders, and yet produces its fructification in a similar manner to the *Fucus vesiculosus*; but the advocates for floescence may attribute the impregnation to the small external filaments so often noticed. *Fucus siliquosus* and *F. nodosus* are perfectly free from those minute fascicles; but then again the impregnation may possibly be ascribed to the tracheæ in the vesicles or inflated leaves. What then remains to be said of the *Fucus canaliculatus*,

dried in the sun, and afterwards deposited, it will in a short time be covered with a white efflorescence of sea salt.

which is entirely destitute both of the vesicles and the external filaments, and yet produces its seeds in a manner exactly similar to that before described?—In short, as the means by which Nature conducts her operations are always appropriate to her ends, we may conclude, that if the fine vessels or fibres in the vesicles had any immediate reference to a state of florescence, they would either be extended throughout the internal substance of the frond, to carry on their secret and subtile operation; or would be furnished with some external apparatus, which might give colour and support to the hypothesis.

A particular description of the air-bladders, or vesicles, which form a curious part in the structure of several of the *Fuci*, will close these remarks. It might naturally occur to any casual observer, that the vesicles alluded to could not be formed, if they had not some means of collecting and retaining a greater portion of air than that which may exist in an equal given space of the solid frond. Nature therefore seems to have furnished them with numerous tracheæ or air-vessels, surpassing in tenuity the finest hair. These are a combination of fibres inosculated together, which proceed from the cellular substance, and freely exert their elastic influence from the interior surface of the cavity. They may be found in all the inflated *Fuci*; and as they are very similar in their appearance, so, probably, they may be in their œconomy, to that fine woolly substance which is found at the broken ends of some leaves, and which the learned Grew has pronounced to be a skein of air-vessels. These capillary vessels in the bladders of the *Fucus* probably contribute their aid to dilate and extend that part of the frond into its oval and vesicular form; and bring part of that elastic fluid into action, which is well known to exist in all plants without exception. Since this paper was written a remark has made its appearance, in a very valuable
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work upon the subject of the *Fuci**, which attributes the formation of those fine vessels to the laceration of the internal substance, as the sides become dilated into the air-bladders. An examination of these slender threads under the microscope will probably induce the observer to entertain a different opinion. If they originated from the cause supposed, they would appear in a lacerated unconnected state; and, being formed from the broken mass, could never be so curiously anastomatized one with another: neither would the relaxed and dissolved contents be drawn out into tubular and jointed forms. Besides, these capillary vessels generally dilate at the point of inosculation, forming a kind of joint, in an uniform manner. It is very difficult to conceive that a texture surpassing in tenuity the finest web, and at the same time so curiously organized, should be produced by a general revulsion of the expanding mass.

* See *Transactions of the Linnean Society*, vol. iii. p. 91, 92.